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TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

A-70150/JAS

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)

09/719245

INTERNATIONAL APPLICATION NO.

PCT/GB99/01848

INTERNATIONAL FILING DATE

June 10, 1999

PRIORITY DATE CLAIMED

June 10, 1998

TITLE OF INVENTION

PEPTIDE

APPLICANT(S) FOR DO/EO/US

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Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☐ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
- ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
- ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
- ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
- ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (Unsigned)
- ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A **FIRST** preliminary amendment.
☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☐ Other items or information:

3001 Rec'd PCT/PTO 08 DEC 2000
CALCULATIONS PTO USE ONLY

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

Neither international preliminary examination fee (37 CFR 1.482)
nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO
and International Search Report not prepared by the EPO or JPO \$1000.00

International preliminary examination fee (37 CFR 1.482) not paid to
USPTO but International Search Report prepared by the EPO or JPO. \$860.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	\$710.00
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International preliminary examination fee paid to USPTO (37 CFR 1.482)
but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00

International preliminary examination fee paid to USPTO (37 CFR 1.482)
and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT = \$1,000.

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
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Total claims	28 - 20 =	8	X \$18.00	\$ 144.
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Independent claims	4 - 3 =	0	X \$80.00	\$
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MULTIPLE DEPENDENT CLAIM(S) (if applicable)	+ \$270.00	\$ 270.
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TOTAL OF ABOVE CALCULATIONS	=	\$
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☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.

SUBTOTAL	=	\$1,410.
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Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).

TOTAL NATIONAL FEE	=	\$1,410.
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Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property	+	\$
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TOTAL FEES ENCLOSED = \$1,410.

Amount to be refunded:	\$
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a. ☒ A check in the amount of \$ 1,410. to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees.
A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 06-1300. A duplicate copy of this sheet is enclosed.
(Order #A-70150/JAS)

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

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REG. NO. 25,435

REGISTRATION NUMBER

JC01 Rec'd PCT/PTD 08 DEC 2000

"Peptide"

The present invention relates to the delivery of molecules into a cell and the use of modified signal peptides.

Specifically, a modified analogue of the signal peptide sequence from Kaposi syndrome fibroblast growth factor (kPGF) is used as a cell-permeant vehicle for the intracellular delivery of covalently linked anti-sense peptide nucleic acid sequences (PNAs).

PNAs have potential uses as antisense molecules for the control of gene expression. Since they are capable of binding tightly to DNA and RNA targets thus preventing DNA transcription to RNA and RNA translation to protein. These molecules thus have two potential uses of commercial importance:

1. As research reagents where scientists use antisense strategies to ablate selected genes in order to understand their function.
2. As pharmaceutical compounds for companies seeking to develop nucleic acid-based therapies.

Conventional anti-sense oligonucleotide *in vivo* delivery is highly inefficient, even if long-lasting, less polar phosphorothioates are used.

This invention covers the use of cell-permeant peptide delivery systems based on the hydrophobic core sequences of any signal peptide sequence. A signal peptide is a short-lived *N*-terminal sequence found only on nascent proteins which are synthesised in the endoplasmic reticulum. Signal peptides consist of three domains:

- (a) *N*-terminus of 1-5 amino acids, often positively charged;
- (b) A hydrophobic core or central region (7-16 amino acids) which is essential for translocation across the endoplasmic reticulum membrane; and
- (c) A more polar C-terminal domain (3-7 amino acids) which is important for specifying the cleavage site.

Synthetic peptides consisting of only the hydrophobic cores are typically insoluble in water. Taking the signal peptide sequence of Kaposi syndrome-derived FGF as an example, we have modified these insoluble sequences by the addition of positively charged amino acids (for example lysines), which have the effect of rendering them water soluble without compromising their ability to translocate across cellular membranes. The ability to add amino groups in this way allows extra cargo sequences to be conjugated to these amino groups.

It is an object of the present invention to provide a cell permeable peptide delivery system based on a

1 signal peptide sequence for the intracellular delivery
2 of peptide nucleic acid sequence.

3
4 According to the present invention there is provided a
5 cell permeable peptide comprising at least the
6 hydrophobic core of a signal peptide or an analogue
7 thereof wherein the peptide is modified by the addition
8 of at least one positively charged amino acids or
9 positively charged analogues thereof.

10
11 The signal peptide may be a natural or synthetic signal
12 peptide or a peptide which is substantially similar
13 thereto.

14
15 A peptide which is substantially similar to a signal
16 peptide is at least 60% homologous thereto.

17
18 At least one positively charged amino acid is chosen
19 from lysine and/or arginine and/or any positively
20 charged analogues thereof.

21
22 In one particular embodiment the cell permeable peptide
23 is a modified analogue of Kaposi syndrome fibroblast
24 growth factor (KFGF).

25
26 The positively charged amino acid consists of one or
27 more lysine residues.

28
29 The invention further provides the use of cell
30 permeable peptides as described herein for
31 intracellular delivery of a molecule.

32
33 Preferably, one or more lysine residues will be
34 attached to the C terminal of the signal sequence
35 peptide or signal sequence peptide analogue.

36

1 This positively charged lysine allows the linkage of a
2 peptide nucleic acid, thus facilitating in vivo
3 delivery of the said peptide nucleic acid.
4

5
6 The invention also provides a cell permeable peptide
7 which contains multiple positively charged amino acids
8 or positively charged analogues thereof wherein a
9 peptide nucleic acid may be conjugated to each
10 positively charged residue and wherein the peptide
11 nucleic acids conjugated by such a means are identical
12 or different.
13

14 The invention also provides a cell permeable peptide
15 which comprises at least one positively charged amino
16 acid residue or functionally equivalent positively
17 charged analogue thereof conjugated or conjugatable to
18 a lysine tree, to which multiple peptide nucleic acids
19 may be joined for transport and presentation.
20

21 The linked peptide nucleic acid sequence may be
22 antisense.
23

24 Preferably, the peptide nucleic acid sequence will be
25 covalently linked.
26

27 The present invention thus allows the use of cell
28 permeable peptides as described herein to deliver
29 peptide nucleic acids to in-vivo targets.
30

31 Use of conventional oligonucleotides is being reduced
32 due to the development of PNAs (Nielsen, et al., 1991),
33 which are much more stable, being resistant to enzymic
34 degradation (Jordan, et al., 1997). PNAs replace the
35 phosphodiester backbone of nucleic acid with repeating
36 N-(2-aminoethyl)glycine units to which natural

1 nucleobases are attached through methylenecarbonyl
2 linkers. Although more stable, PNAs suffer from
3 similar accessibility problems as phosphorothioates do,
4 and passive diffusion of unmodified PNA across lipid
5 membranes is not efficient (Wittung, P., et al., 1995).

6
7 A small number of native peptide sequences can
8 translocate across membranes of living cells in an
9 energy-independent and receptor-independent manner.
10 These peptides have been used to import active cargo
11 into the cell. For example a peptide from the
12 homeodomain of *Antennapedia* has been successfully used
13 to import both peptidal inhibitors of protein kinase C
14 (Theodore, et al., 1995) and conventional anti-sense
15 oligonucleotides (Allinquant, et al., 1995).

16
17 The present invention provides use of cell permeable
18 peptide import (CPPI) to deliver peptide nucleic acids
19 (PNAs).

20
21 The present invention provides use of the signal
22 peptide sequence from Kaposi syndrome fibroblast
23 growth factor (KFGF) for delivery of antisense peptide
24 nucleic acid sequences (PNAs).

25
26 The invention provides use of a peptide as defined
27 herein together with lysine residues for multiple
28 presentation of peptide nucleic acids.

29
30 The invention further provides use of peptides as
31 defined herein together with lysine residues in the
32 simultaneous presentation of different peptides nucleic
33 acids.

34
35 The present invention combines the two above
36 technologies to use CPPI to deliver PNAs to *in vivo*

1 targets.

2
3 The invention described herein has the following
4 advantages:

- 5
6 - The modified signal peptides described in this
7 invention can be used for the delivery of any
8 cell-impermeant substance into cells.
9
10 - The signal peptides described in this invention
11 can be used to improve the delivery of substances
12 of low permeability into cells.
13
14 - The delivery of substances to particular cellular
15 sub-compartments can be achieved and improved by
16 incorporating appropriate targeting peptide
17 sequences or other modifications to the signal
18 peptides. Effects are only due to the 'cargo'
19 substance that they carry. For example, addition
20 of a myristoyl moiety to the peptide would ensure
21 that it was preferentially retained at the plasma
22 membrane.
23
24 - The signal peptide delivery system has commercial
25 value in therapeutic drug-delivery systems
26 including, but not restricted to, gene therapy,
27 cancer therapy and anti-infectious agent therapy.
28
29 - This system also has commercial value as a tool
30 for biochemical and molecular biological research.
31
32 - The modified signal peptides described in this
33 invention do not, themselves, exhibit any
34 biological effects nor do they affect cell
35 viability. Effects are only due to the 'cargo'
36 substance that they carry.

This invention will be exemplified in the following non-limiting examples with reference to the accompanying figures wherein:-

Figure 1 illustrates carboxyfluorescein labelled kFGF signal peptide-Lys.Lys.Lys - fluorescence calibration curve.

Figure 2 illustrates carboxfluorescein labelled cell permeant peptide incorporation by whole human endothelial cells.

Figure 3 depicts incorporation of carboxyfluorescein labelled signal peptide-Lys.Lys.Lys by cell.

Figure 4 illustrates subcellular distribution of labelled signal peptide in cells.

Figure 5 depicts incorporation of labelled kFGF peptide into human dermal endothelial cells.

Figure 6a sets out the signal peptide sequence and modifications.

Figure 6b illustrates simultaneous presentation of 3 PNAs directed to different sites on a target RNA.

Figure 6c illustrates multiple presentation of the single PNA species.

Table 1 describes carboxyfluorescein derivatised cell permeant peptides.

Table 2a sets out uptake of cell permeant peptides by cells.

Table 2b sets out cellular uptake of permeant peptides by BHK cells.

Table 3 sets out results of washing labelled antennapedia cells.

Table 4 sets out washing results for labelled signal peptide-KKK and cells.

EXAMPLE 1

This is an example of the intracellular delivery of a low molecular weight compound (carboxyfluorescein) which is normally cell impermeant.

In order to determine the best delivery system, a comparison of the ability of four different cell permeant peptides (Table 1) to accumulate in whole cells was undertaken. The four peptide sequences were synthesised to contain carboxyfluorescein as a reporter group (Table 1), allowing intracellular accumulation to be monitored by fluorescence. Whole cells were exposed to 50 μ M solutions of each peptide for 24 hours (37°C) and accumulation was measured using a fluorometer. The results of this are shown in Tables 2A and 2B.

The results shown in the whole column of Table 2A were provided by cell suspensions being exposed to 50 μ M peptide each, for 24 hours at 37°C. Incubations contained 3.28×10^6 cells in 1 ml. Subcellular fractionation was then carried out. Fluorescence measured with excitation $\lambda = 471$ nm, emission $\lambda = 521$ nm. RFU values were converted to nMoles per 10^6 cells.

The raw relative fluorescent units (RFU) values were converted to nMoles per 10^6 cells using a calibration

curve constructed for each peptide. An example of a fluorescence calibration curve of fluorescein labelled kFGF is shown in Figure 1.

The kFGF-KKK sequence (see Figure 3) shows similar high rates of cytosolic and nuclear incorporation compared with the antennapedia peptide (Table 2A). The PKC and substance P peptides show much lower incorporation (Table 2A & 2B). Incorporation of the kFGF-KKK sequence is saturable, as can be seen from the data presented on Figure 2 and time-dependent as shown in Figure 3.

Table 2A shows that antennapedia is lost during subcellular fractionation. Unlike the antennapedia peptide, carboxyfluorescein-kFGF signal peptide-KKK is not loosely attached to the cell surface as shown in Tables 3 and 4. Unlike the antennapedia peptide, carboxyfluorescein-kFGF signal peptide-KKK does not remain membrane-bound as shown by the data presented in Figure 4.

It should be noted from Figure 4 that all cells treated with carboxyfluorescein - labelled kFGF signal peptide Lysine-Lysine-Lysine have nuclear and cytoplasmic incorporation. Unlike antennapedia, very little remains stuck in the cell membrane.

EXAMPLE 2 - Anti-sense agents for gene ablation

Conventional oligonucleotide sequences or those in which the phosphodiester bonds are replaced with nuclease-resistant bonds (such as the phosphothiorates and the like) may be conjugated to the kFGF-derived delivery system for intracellular delivery and subsequent specific blocking of gene translation or RNase-targeted destruction of the mRNA in question.

Alternatively peptide nucleic acid sequences may be used, as in example 1.

Although the "cargo" to be delivered intracellularly is referred to in the text and represented in the accompanying figures as a Peptide Nucleic Acid (PNA), it should not be limited to such cargo type as the various configurations of CPPI described in this Patent could also be used to carry peptide sequences or oligonucleotide sequences (either native sequences or modified sequences, such as phosphothiorates).

It has been demonstrated that addition of a peptide nucleic acid sequence does not impede incorporation of the carboxyfluorescein-kFGF signal peptide-{PNA}-KKK. The confocal micrograph shown in Figure 5 illustrates this.

EXAMPLE 3

Nuclear localisation signal (NLS) sequences such as are found on transcription factors like NF-kappaB may be conjugated to the kFGF-derived delivery system, as in Example 1. Intracellular delivery of NLS peptide sequences would act as 'bait' to selectively block the translocation of the selected transcription factor, thus preventing its action. In this way, genes under the control of the transcription factor could be identified on the basis of down regulated expression.

EXAMPLE 4

Signal transduction motifs such as phosphotyrosine-containing peptide sequences (pYP's) act as docking sites for a large number of proteins. Such signalling proteins contain domains that recognise (contextually)

the phosphotyrosine residues and bind to them in a specific manner. pYP's are recognised by SH-2 (Src-homology-2) domains and PTB (phosphotyrosine binding domains). Specificity is provided by short amino acid sequences N-and/or C-terminal of the phosphotyrosine. Such peptide motifs could be conjugated to the kFGF peptide-derived delivery system as in Example 1, and could be used to intracellularly deliver pYP's which would act as bait, thus allowing signal pathways to be 'interrogated'.

The signal sequence of kFGF was modified to contain three lysines at the C-terminal of the hydrophobic signal sequence. This procedure is illustrated in Figure 6A. In this Figure 6A (I) shows the signal peptide with an attached reporter group. Figure 6A Part II illustrates the addition of the tri-lysine extension to the C-terminal of the signal peptide sequence, thus providing three positive charges which aid solubility and cell permeability. In Figure 6A Part IIIb, the peptide nucleic acid forms part of the linear primary amino acid sequence, with Part IV illustrating a tri-lysine C-terminal extension to the peptide nucleic acid sequence providing 3 positive charges and aiding solubility and cell permeability.

Part V of Figure 6A further shows a tri-lysyl extension at the N-terminal of the signal peptide which provides 3 positive charges aiding solubility and cell permeability. The addition of the tri-lysyl extension proximal to the carboxyfluorescein reporter group enhances its fluorescence. In Vb of Figure 6A, the peptide nucleic acid sequence initially forms part of the linear primary amino acid sequence at the N-terminal of the original peptide, before a tri-lysyl extension is added to the N-terminal of the peptide

nucleic acid extension.

It should be noted that although the above examples specifically use the amino acid lysine for the addition of positive charge, molecules containing similar properties such as arginine or analogues thereof, of either of these molecules could also be used.

This peptide, therefore, can accommodate three PNAs, each bonded to a lysine epsilon amino group. This can be extended using the Multiple Antigen Presentation (MAP) technology to present eight (or more) PNA's on one kFGF signal sequence. A 'lysine tree' constructed in this way accommodates eight copies of the same PNA, thus increasing the effective concentration delivered by each CPPI.

An example of the addition of such a lysine tree is shown in Figure 6C Parts I-IV. In Part I a single lysine molecule added to the C-terminal of the kFGF signal peptide sequence allows the multiple PNA lysine tree to be added to the e-amino group of the lysine side chain.

Alternatively, Part II of Figure 6C a lysine molecule added to the N-terminal of the kFGF signal peptide sequence allows the multiple PNA lysine tree to be added to the e-amino group of the lysine side chain.

Part III of Figure 6C further shows that when a C-terminal tri-lysine extension is added to the signal peptide with N-terminal associated multiple PNA lysine tree, the 3 positive charges aid solubility and cell permeability of the molecule.

Part IV of Figure 6C add a tri-lysyl extension at the

1 N-terminal of the signal peptide which is attached to
2 the lysine group added to allow attachment of the
3 multiple PNA lysine tree as originally illustrated in
4 Figure 6C Part II. The addition of the 3 positively
5 charged molecules at this terminal of the molecule,
6 proximal to the carboxyfluorescein reporter group
7 enhances its fluorescence.

8
9 Alternatively a carrier can be constructed containing
10 three (or more) different PNAs directed towards
11 different sites on the same target mRNA. This strategy
12 has been termed 'molecular triangulation' (Branch,
13 A.D., 1998).

14
15 Figure 6B illustrates this process of 'molecular
16 triangulation'. Figure 6B Part I shows the signal
17 peptide with a C-terminal tri-lysyl extension which
18 allows three different PNA sequences to be conjugated
19 to the epsilon-amino groups of the three lysines.

20
21 Figure 6B Part III shows the addition of a further
22 three lysines to the molecule of Part I, which adds
23 three positive charges, which aid solubility and cell
24 permeability. Figure 6B Part III shows the addition of
25 the tri-lysyl extension to the N-terminal of the
26 molecule of Part I. Again the 3 positive charges aid
27 the solubility and cell permeability of the molecule,
28 which their proximal location to the carboxyfluorescein
29 reporter group enhances its fluorescence.

30
31 Figure 6B, Part IV, illustrates an N-terminal tri-lysyl
32 extension added to the kFGF signal peptide sequence,
33 which subsequently allows three different PNA sequences
34 to be conjugated to the epsilon-amino groups of the
35 lysines.
36

Further, this molecule has 3 lysines added at the C-terminal to add positive charge which aid solubility and cell permeability. Figure 6B Part V shows the signal peptide again with the three peptide nucleic acid associated tri-lysine extension at the N-terminal, but with the addition of the further 3 lysine groups also being made to the N-terminal where they will have the effect of aiding solubility and cell permeability, which also enhance the fluorescence of the carboxyfluorescein reporter group due to their proximity.

Further to the sequences illustrated in Figures 6A and 6C additional tri-lysine extensions at either end of the molecule, appears to aid solubility and cell permeability to allow PNA sequences to be transported. Therefore in addition to using lysine residues to attach to PNA sequences, additional tri-lysine extension is recommended. Examples of presentation peptide using the additional try-lysine is demonstrated in Figures 6B (II-IV), Figures 6C (III-IV) and Figures 6A (IV, IVb, V, Vb).

Lysine extensions comprising more or less than three lysine residues may also be useful to provide additional solubility and cell permeability.

The lysine extension may be provided next to a carboxyfluorescein reporter group to enhance its fluorescence.

References

Allinquant, B., Hantraye, P., Mailleux, P., Moya, K., Bouilliot, C. and Prochiantz, A (1995) Downregulation of amyloid precursor protein inhibits neurite outgrowth in vitro *J. Cell Biol.*, **128**: 919-927.

Branch, A.D. (1998) A good antisense molecule is hard to find. *TIBS*, **23**: 45-50.

Jordan, S., Schwemler, C., Kosch, W., Kretschner, A., Schwenner, E., Stropp, U. and Mielke, B. (1997) Synthesis of new building blocks for peptide nucleic acids containing monomers with variations in the backbone. *Bioorg. Med. Chem. Lett.*, **7**: 681-686.

Neilsen, P.E., Egholm, M., Berg, R.H. and Buchardt, O. (1991) Sequence-selective recognition of RNA by strand displacement with a thymine-substituted polyamide. *Science*, **254**: 1497-1500.

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Wittung, P., Kajanus, J., Edwards, K., Haaime, G., Nielson, P., Norden, B. and Malmstrom, B.G. Phospholipid membrane-permeability of peptide nucleic acid (1995) *FEBS Lett.*, **375**: 317-320.

CLAIMS

- 1 A cell permeable peptide comprising at least the hydrophobic core of a signal peptide or an analogue thereof wherein the peptide is modified by at least the addition of at least one positively charged amino acid or positively charged analogue thereof.
- 2 A cell permeable peptide as claimed in claim 1 wherein the signal peptide is a natural or synthetic signal peptide or a peptide which is substantially similar thereto.
- 3 A cell permeable peptide as claimed in claim 1 and 2 wherein at least one positively charged amino acid is chosen from lysine and/or arginine and/or any positively charged analogue thereof.
- 4 A cell permeable peptide as claimed in any preceding claim wherein the cell permeable peptide is a modified analogue of Kaposi syndrome fibroblast growth factor (KFGF).
- 5 A cell permeable peptide as claimed in any preceding claim where in the positively charged amino acid consists of one or more lysine residues.
- 6 A cell permeable peptide as claimed in claim 5 wherein one or more lysine residues are attached to the C-terminal of the signal sequence peptide or signal sequence peptide analogue.
- 7 A cell permeable peptide as claimed in any of claims 1 to 6 which contains multiple positively

1 charged amino acids or positively charged
2 analogues thereof, wherein a peptide nucleic acid
3 may be conjugated to each positively charged
4 residue and wherein the peptide nucleic acids
5 conjugated by such means are identical or
6 different.
7

8 8 A cell permeable peptide as claimed in any of
9 claims 1 to 6 which comprises at least one
10 positively charged amino acid residue or
11 functionally equivalent positively charged
12 analogue thereof, conjugated or conjugatable to a
13 lysine tree, to which multiple peptide nucleic
14 acids may be joined for transport and presentation
15 of multiple peptide nucleic acids.
16

17 9 Use of cell permeable peptides claimed in any of
18 the preceding claims for intracellular delivery of
19 a molecule.
20

21 10 Use of a cell permeable peptide as claimed in any
22 of claims 1 to 8 to deliver peptide nucleic acids
23 to *in-vivo* targets.
24

Figure 1

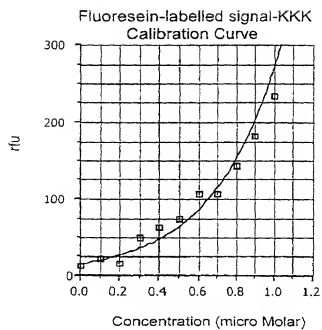


Figure 2

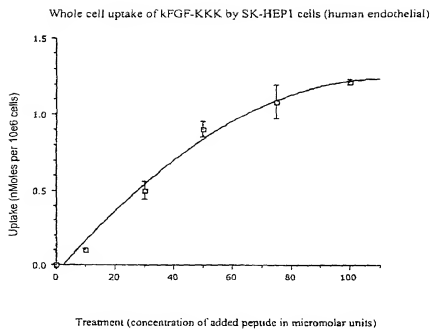


Figure 3



15 minutes



30 minutes



45 minutes



1 hour

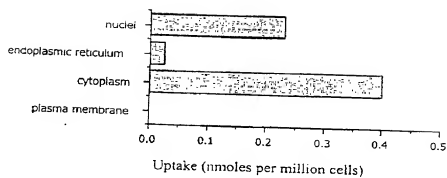


4 hours



24 hours

Figure 4



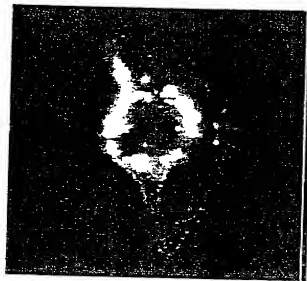
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WO 99/64449

5/14

PCT/GB99/01848

Figure 5



SUBSTITUTE SHEET (RULE 26)

6/14

Figure 6A

A.A.V.A.L.L.P.A.V.L.L.A.L.L.A.P

6A(I).

CarboxyFluor -A.A.V.A.L.L.P.A.V.L.L.A.L.L.A.P

6A(II)

CarboxyFluor -A.A.V.A.L.L.P.A.V.L.L.A.L.L.A.P. K.K.K

6A(III)

CarboxyFluor -A.A.V.A.L.L.P.A.V.L.L.A.L.L.A.P- [PNA SEQUENCE]

6A(IIIb)

CarboxyFluor -A.A.V.A.L.L.P.A.V.L.L.A.L.L.A.P- [PNA SEQUENCE] -K.K.K

6A(IV)

CarboxyFluor -A.A.V.A.L.L.P.A.V.L.L.A.L.L.A.P. K.K.K [PNA SEQUENCE]

6A(IVb)

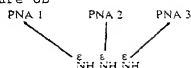
CarboxyFluor -K.K.K ---A.A.V.A.L.L.P.A.V.L.L.A.L.L.A.P- [PNA SEQUENCE]

6A(V)

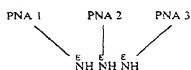
CarboxyFluor -K.K.K [PNA SEQUENCE] -A.A.V.A.L.L.P.A.V.L.L.A.L.L.A.P

6A(Vb)

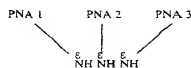
Figure 6B

6B(I)

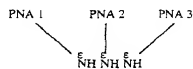
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6B(II)

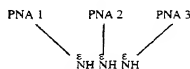
CarboxyFluor-A.A.V.A.L.L.P.A.V.L.L.A.L.L.A.P.K-K-K.K.K.K

6B(III)

CarboxyFluor-K.K.K. A.A.V.A.L.L.P.A.V.L.L.A.L.L.A.P. K-K-K

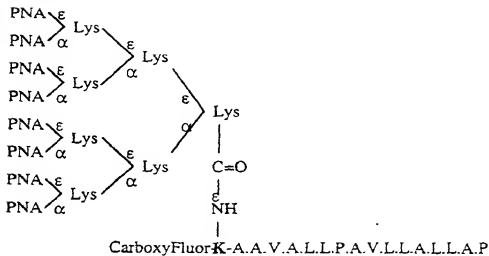
6B(IV)

CarboxyFluor-K-K-K. A.A.V.A.L.L.P.A.V.L.L.A.L.L.A.P. K.K.K

6B(V)

CarboxyFluor.K.K.K.-K-K-K. A.A.V.A.L.L.P.A.V.L.L.A.L.L.A.P

6C(1)



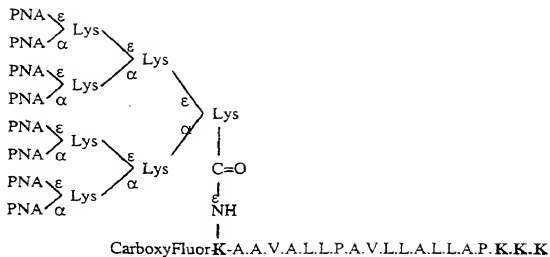
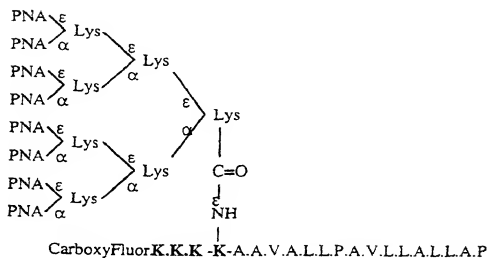
6C(III)6C(IV)

Table 1

Carboxyfluorescein-derivatised Cell Permeant Peptides*																				
kFGF signal sequence	cFl	A	A	V	A	L	L	P	A	V	L	L	A	L	L	A	P	K	K	K
PKC substrate - substrate	cFl	R	F	A	R	K	G	A	L	R	Q	K	N	V	H	E	V	K	N	
Substance P	cFl	R	P	R	P	Q	Q	F	Ø	G	L	M								
Antennapedia	cFl	R	Q	I	K	I	W	F	Q	N	R	R	M	K	W	K	K			

*Modifications of original sequence marked in bold (ø = ornithine, cFl = carboxyfluorescein).

Table 2A

	*WHOLE CELL nmoles per 10 ⁶ cells	CYTOSOL nmoles per 10 ⁶ cells	NUCLEI nmoles per 10 ⁶ cells
FGF-KKK	0.79	0.37	0.35
KKK-FGF-KKK	0.24	0.046	0.15
Substance P	0.03	0.005	0.015
PKC pseudo - substrate	0.034	0.015	0.007
Antennapedia	1.22	0.34	0.35

*Cell suspensions were exposed to 50 μ M peptide each, for 24 hours, at 37°C,
=471nm, emission λ = 521nm. RFU values were converted to nMoles per 10⁶ cells

Table 2B

CPPI sequence tested	Amount in nuclei (nmoles per 10^6 cells)	Amount in cytosol (nmoles per 10^6 cells)	Cytosolic concentration (μ M)
kFGF signal peptide	0.035	0.0567	13.5
SubstanceP analogue	0.0005	0.0018	0.42
PKC pseudosubstrate	0.0005	0.00156	0.37

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Table 3

Treatment	rfu
1st PBS wash -	114
2nd PBS	57.34
3rd	21.08
4th PBS/acid wash	15.36

Table 4

Incorporation Treatment	incorporation (nmoles per 106 cells)
PBS wash (after 15min exposure)	0.64
Acid Wash (15min)	0.525
PBS wash (after 24hour exposure)	0.75
Acid wash (after 24hour exposure)	0.53

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02

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **PEPTIDE**, the specification of which

☐ is attached hereto

☒ was filed on: June 10, 1999
as Application Serial No.: PCT/GB99/01848

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Patent Office all information known to me to be material to patentability as defined in 37 C.F.R. 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed
<u>9812376.3</u>	<u>GB</u>	<u>10/06/98</u>	<input checked="" type="checkbox"/> <input type="checkbox"/>
(Number)	(Country)	(Day/Month/Year Filed)	Yes No
<u>9814888.5</u>	<u>GB</u>	<u>10/07/98</u>	<input checked="" type="checkbox"/> <input type="checkbox"/>
(Number)	(Country)	(Day/Month/Year Filed)	Yes No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose to the Patent Office all information known to me to be material to patentability as defined in 37 C.F.R. 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)

(Filing Date)

(Status: patented, pending, abandoned)

I hereby appoint the following attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: Harold C. Hobbach, Reg. No. 17,757; Aldo J. Test, Reg. No. 18,048; Donald N. MacIntosh, Reg. No. 20,316; Edward S. Wright, Reg. No. 24,903; David J. Brezner, Reg. No. 24,774; Robert B. Chickering, Reg. No. 24,286; Richard F. Trecartin, Reg. No. 31,801; Steven F. Caserza, Reg. No. 29,780; Michael A. Kaufman, Reg. No. 32,988; Edward N. Bachand, Reg. No. 37,085; R. Michael Ananian, Reg. No. 35,050; Robin M. Silva, Reg. No. 38,304; David C. Ashby, Reg. No. 36,432; Maria S. Swiatk, Reg. No. 37,244; Todd A. Lorenz, Reg. No. 39,754; provided that if any one of said attorneys ceases being affiliated with the law firm of Flehr Hobbach Test Albritton & Herbert LLP as partner, employee or of counsel, such attorney's appointment as attorney and all powers derived therefrom shall terminate on the date such attorney ceases being so affiliated.

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03

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Title 18, United States Code, §1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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